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Tanaka et al.

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(54) **MOBILE TERMINAL THAT DETERMINE WHETHER THE USER IS WALKING WHILE WATCHING THE MOBILE TERMINAL**

(71) Applicant: **FUJITSU TEN LIMITED**, Kobe-shi, Hyogo (JP)

(72) Inventors: **Shinichi Tanaka**, Kobe (JP); **Hironori Ichioka**, Kobe (JP)

(73) Assignee: **FUJITSU TEN LIMITED**, Kobe-shi (JP)

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H04W 24/00 (2009.01)
H04W 4/22 (2009.01)
H04W 4/02 (2009.01)

(52) **U.S. Cl.**

CPC ***H04W 4/22*** (2013.01); ***H04W 4/027*** (2013.01)

(58) **Field of Classification Search**

CPC H04W 4/025; H04W 4/027; H04W 4/22
USPC 455/404.1, 456.1
See application file for complete search history.

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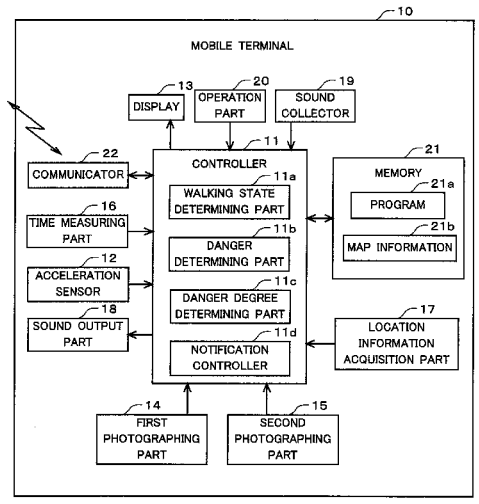
Primary Examiner — William D Cumming
(74) *Attorney, Agent, or Firm* — Oliff PLC

(57) **ABSTRACT**

A mobile terminal includes a display screen, a first camera that is installed on a side of the mobile terminal having the display screen, a velocity sensor that derives moving velocity of the mobile terminal, and a controller configured to (i) determine a starting state of the display screen, (ii) determine a direction of a face of a user based on a shot image obtained from the first camera, and (iii) determine whether the user is walking while watching the mobile terminal based on the moving velocity, the starting state and the direction of the face of the user.

17 Claims, 13 Drawing Sheets



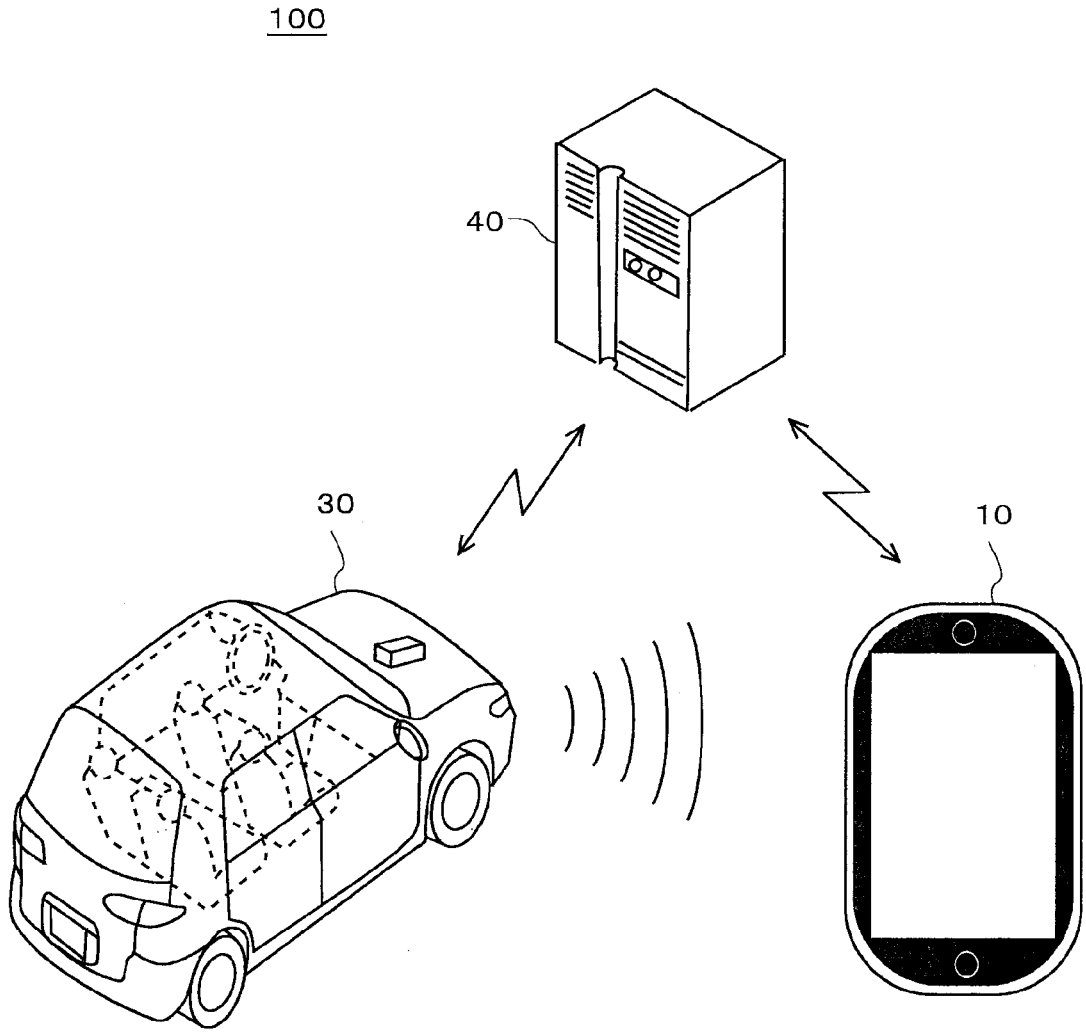


FIG.1

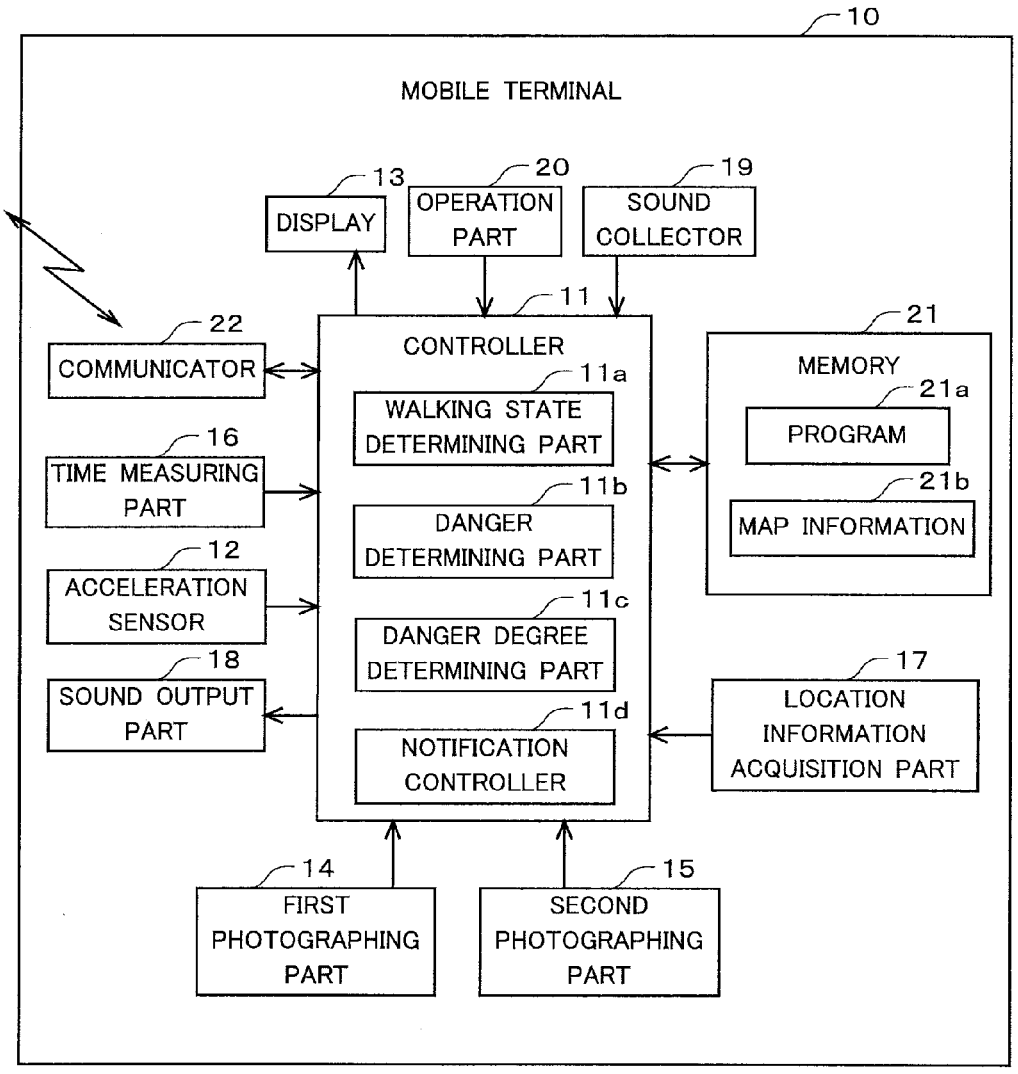

10
MOBILE TERMINAL
13
DISPLAY
20
OPERATION PART
19
SOUND COLLECTOR
11
CONTROLLER
22
COMMUNICATOR
11a
WALKING STATE DETERMINING PART
21
MEMORY
21a
PROGRAM
21b
MAP INFORMATION
16
TIME MEASURING PART
11b
DANGER DETERMINING PART
12
ACCELERATION SENSOR
11c
DANGER DEGREE DETERMINING PART
18
SOUND OUTPUT PART
17
LOCATION INFORMATION ACQUISITION PART
11d
NOTIFICATION CONTROLLER
14
FIRST PHOTOGRAPHING PART
15
SECOND PHOTOGRAPHING PART

FIG.2

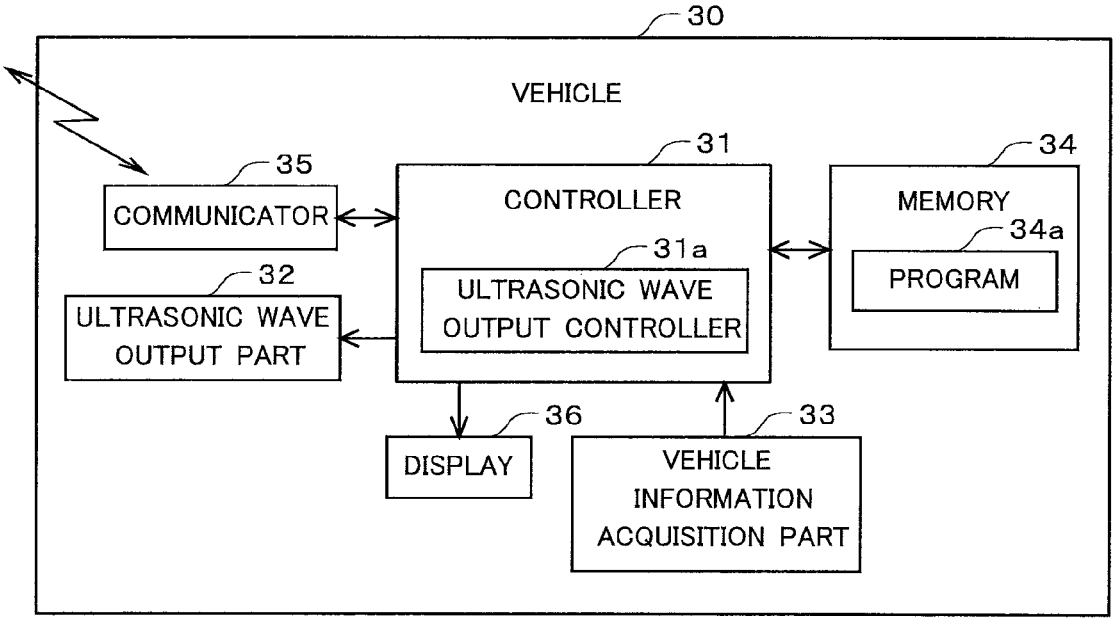

30
VEHICLE
35
COMMUNICATOR
31
CONTROLLER
31a
ULTRASONIC WAVE OUTPUT CONTROLLER
34
MEMORY
34a
PROGRAM
32
ULTRASONIC WAVE OUTPUT PART
36
DISPLAY
33
VEHICLE INFORMATION ACQUISITION PART

FIG.3

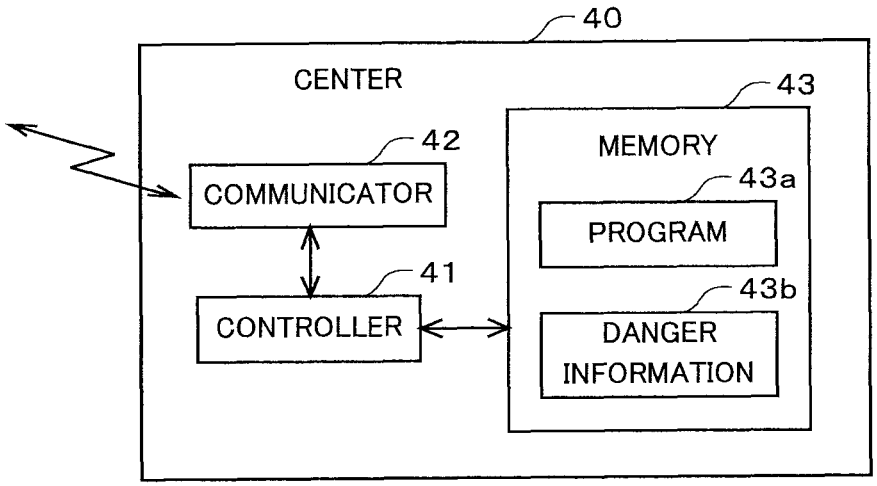

40
CENTER
43
MEMORY
42
COMMUNICATOR
43a
PROGRAM
41
CONTROLLER
43b
DANGER
INFORMATION

FIG.4

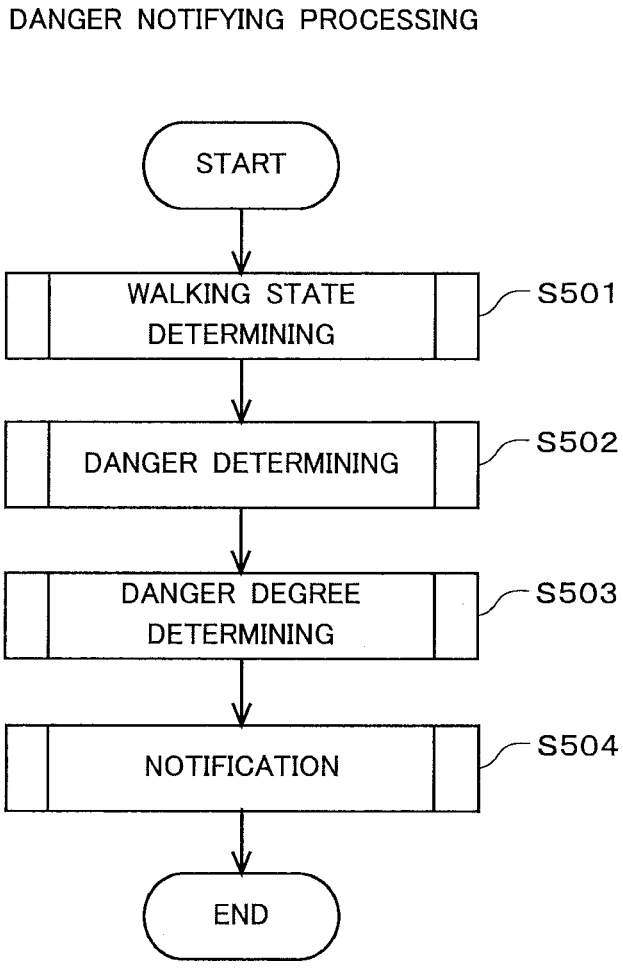

DANGER NOTIFYING PROCESSING
START
WALKING STATE DETERMINING
S501
DANGER DETERMINING
S502
DANGER DEGREE DETERMINING
S503
NOTIFICATION
S504
END

FIG.5

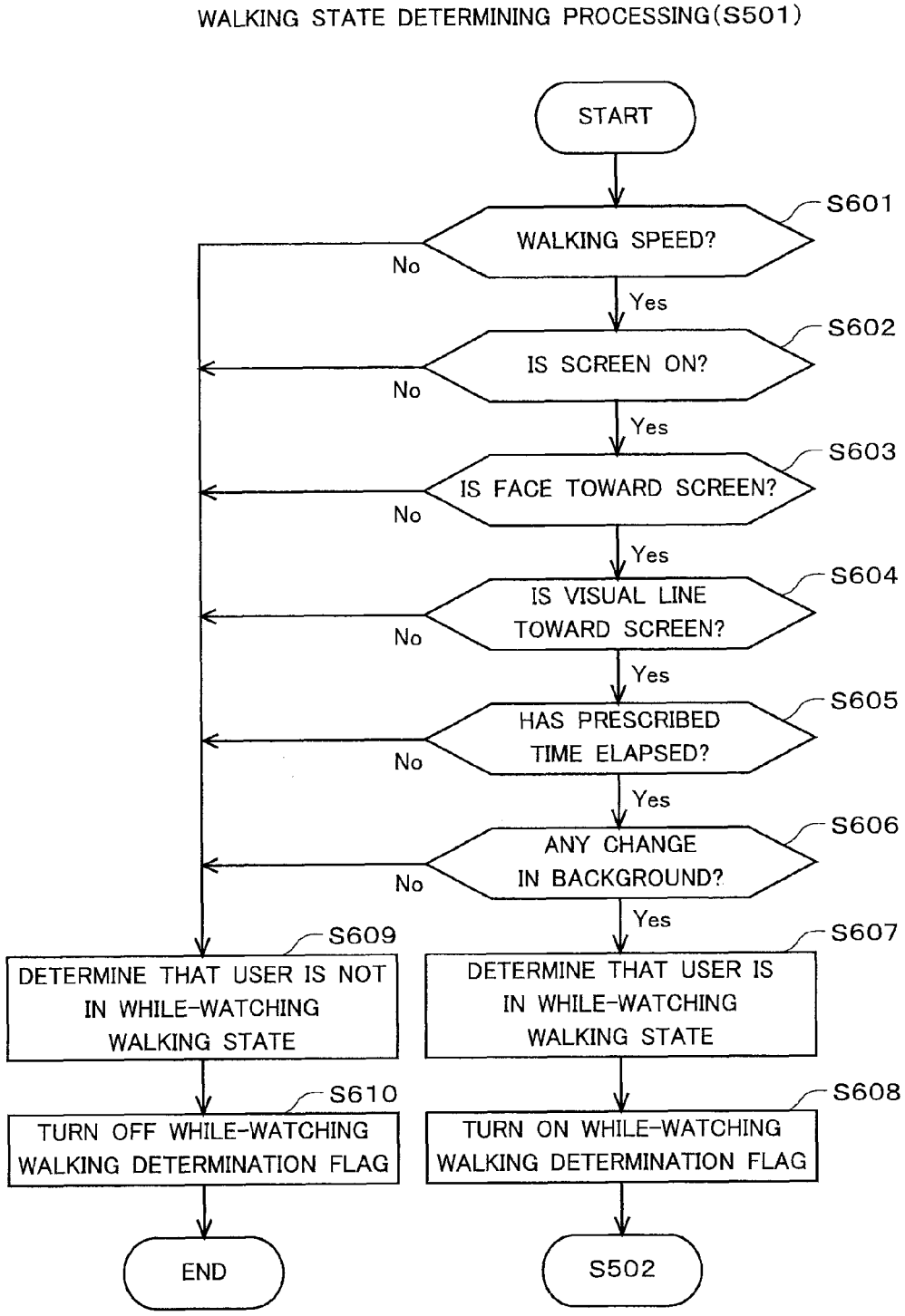

WALKING STATE DETERMINING PROCESSING(S501)
START
S601
WALKING SPEED?
No
Yes
S602
IS SCREEN ON?
No
Yes
S603
IS FACE TOWARD SCREEN?
No
Yes
S604
IS VISUAL LINE TOWARD SCREEN?
No
Yes
S605
HAS PRESCRIBED TIME ELAPSED?
No
Yes
S606
ANY CHANGE IN BACKGROUND?
No
Yes
S609
DETERMINE THAT USER IS NOT IN WHILE-WATCHING WALKING STATE
S607
DETERMINE THAT USER IS IN WHILE-WATCHING WALKING STATE
S610
TURN OFF WHILE-WATCHING WALKING DETERMINATION FLAG
S608
TURN ON WHILE-WATCHING WALKING DETERMINATION FLAG
END
S502

FIG.6

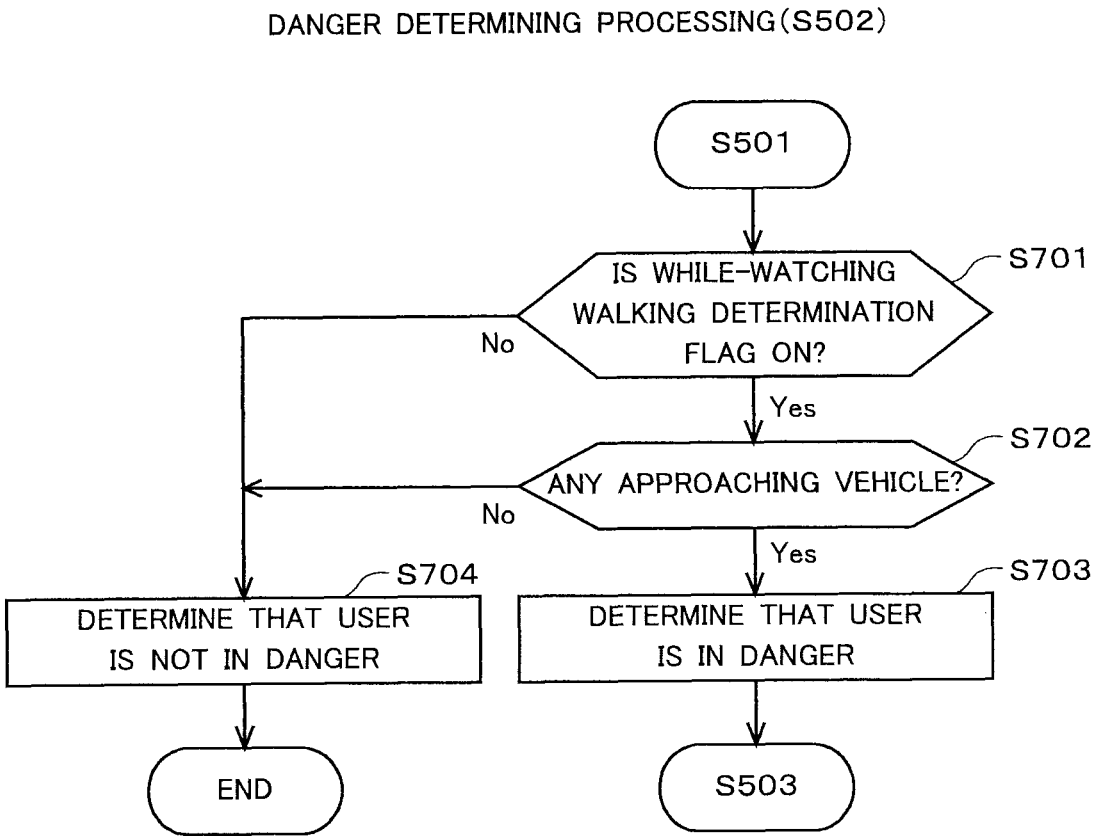

DANGER DETERMINING PROCESSING(S502)
S501
IS WHILE-WATCHING WALKING DETERMINATION FLAG ON?
S701
No
Yes
ANY APPROACHING VEHICLE?
S702
No
Yes
DETERMINE THAT USER IS NOT IN DANGER
S704
DETERMINE THAT USER IS IN DANGER
S703
END
S503

FIG.7

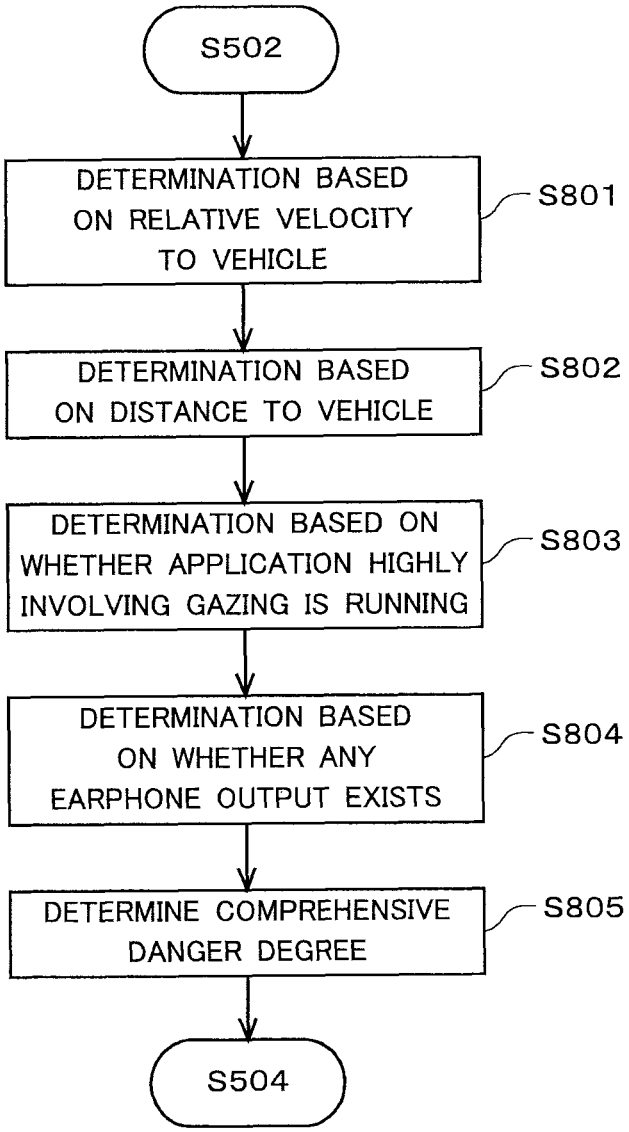

S502
DETERMINATION BASED ON RELATIVE VELOCITY TO VEHICLE
S801
DETERMINATION BASED ON DISTANCE TO VEHICLE
S802
DETERMINATION BASED ON WHETHER APPLICATION HIGHLY INVOLVING GAZING IS RUNNING
S803
DETERMINATION BASED ON WHETHER ANY EARPHONE OUTPUT EXISTS
S804
DETERMINE COMPREHENSIVE DANGER DEGREE
S805
S504

FIG.8

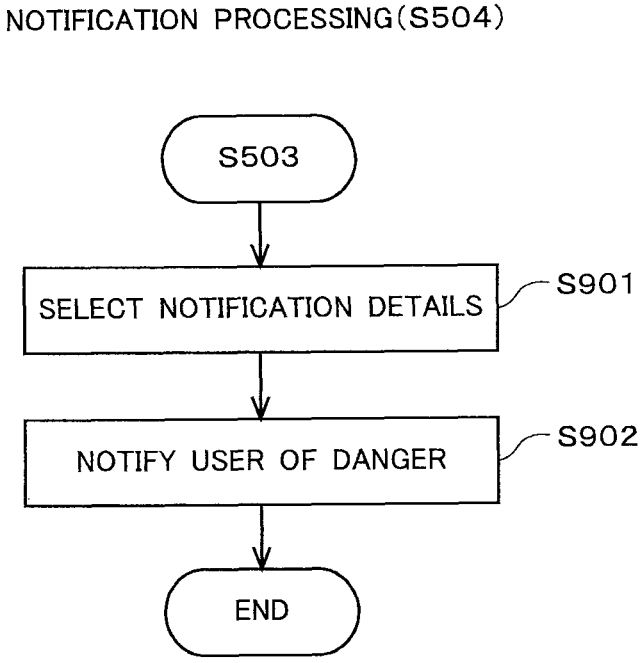

NOTIFICATION PROCESSING(S504)
S503
SELECT NOTIFICATION DETAILS
S901
NOTIFY USER OF DANGER
S902
END

FIG.9

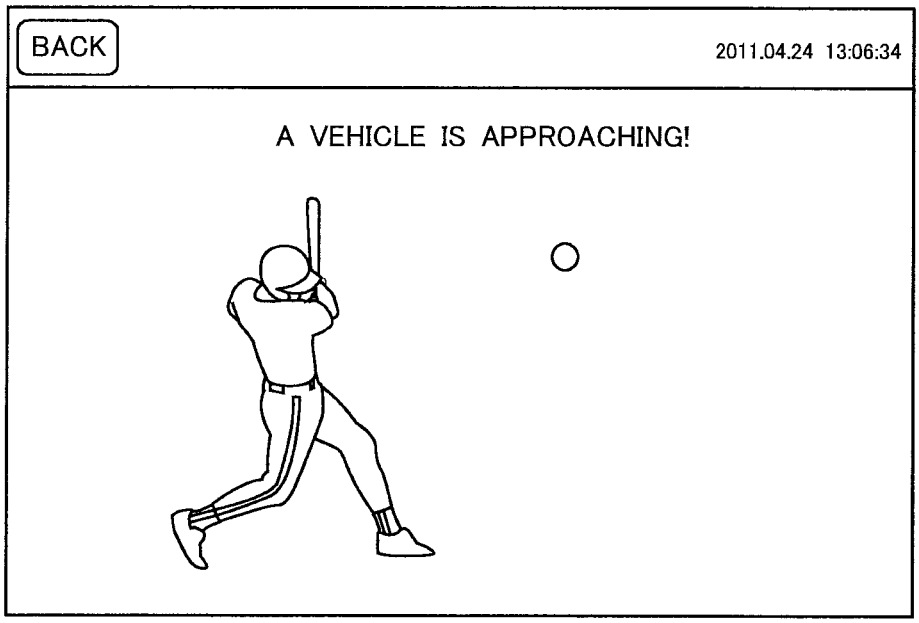


FIG.10

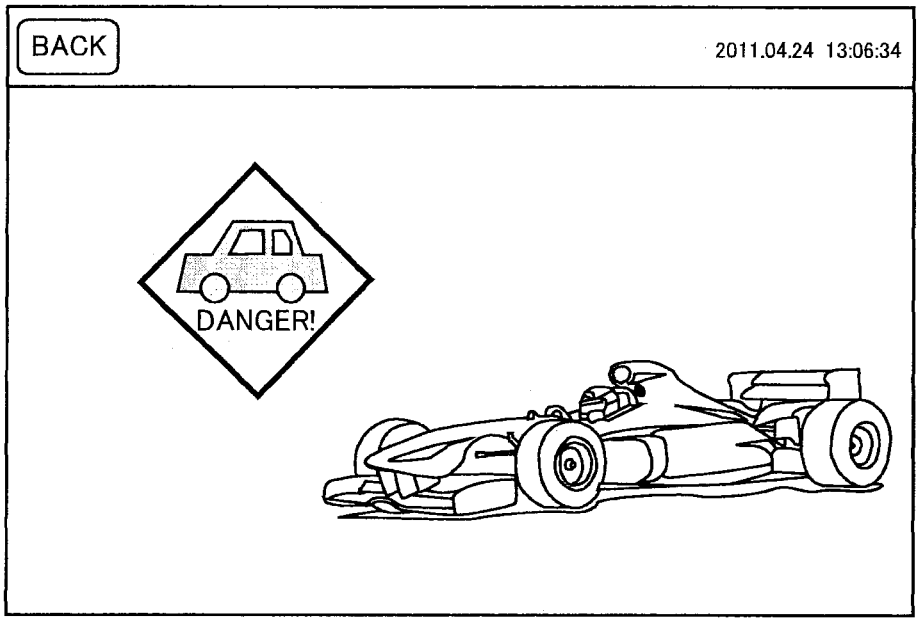


FIG.11

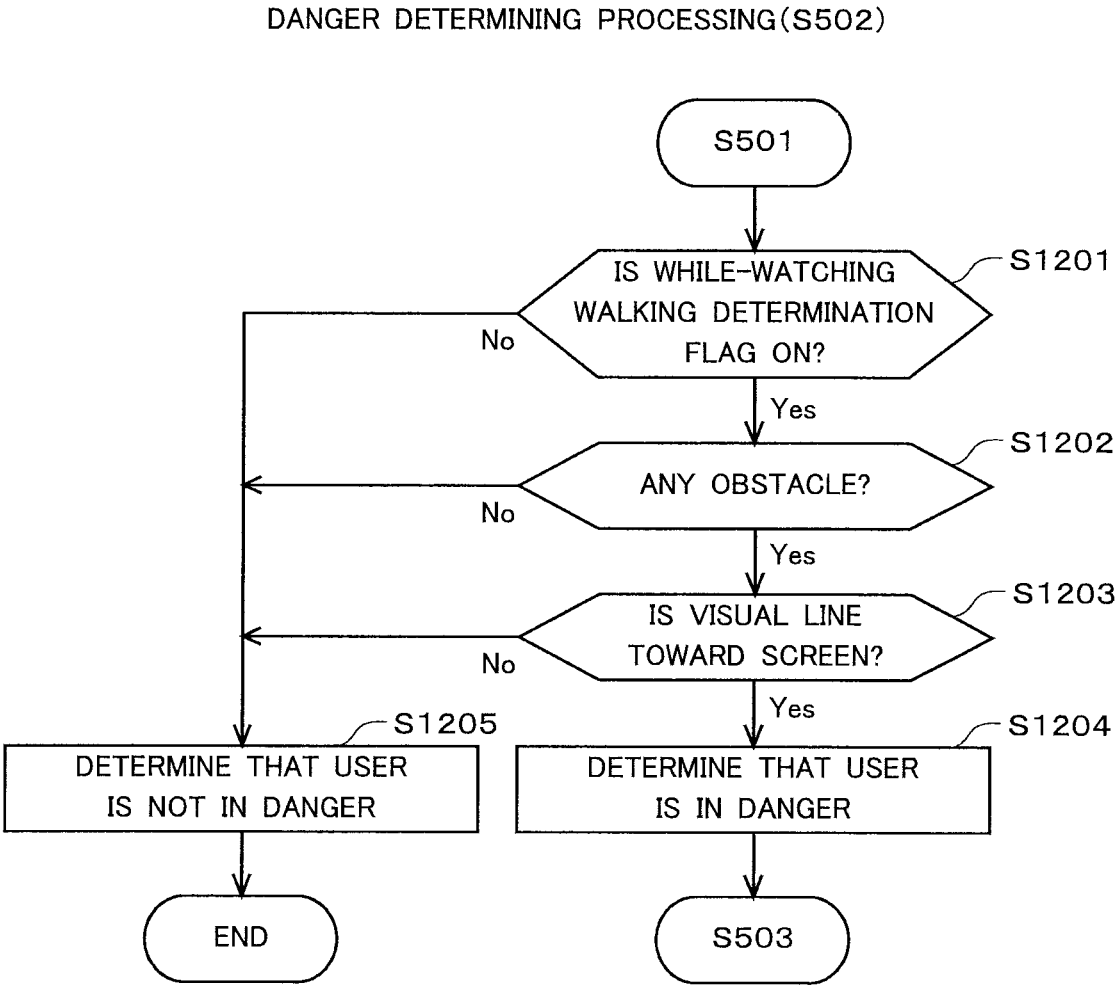

DANGER DETERMINING PROCESSING(S502)
S501
IS WHILE-WATCHING WALKING DETERMINATION FLAG ON?
S1201
No
Yes
ANY OBSTACLE?
S1202
No
Yes
IS VISUAL LINE TOWARD SCREEN?
S1203
No
Yes
DETERMINE THAT USER IS NOT IN DANGER
S1205
DETERMINE THAT USER IS IN DANGER
S1204
END
S503

FIG.12

DANGER DEGREE DETERMINING PROCESSING(S503)

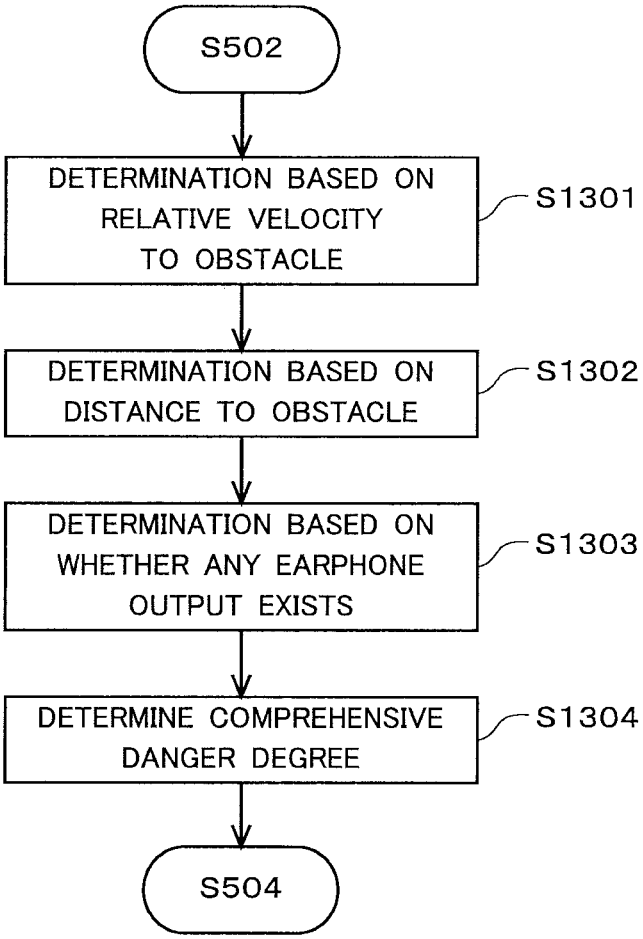


FIG.13

MOBILE TERMINAL THAT DETERMINE WHETHER THE USER IS WALKING WHILE WATCHING THE MOBILE TERMINAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a technology that performs notification of danger by use of a mobile terminal.

2. Description of the Background Art

These days, the number of traffic accidents of pedestrians walking while using mobile devices (e.g., mobile phone, smartphone) is increasing. A user who is walking while watching a mobile device rarely turns his or her visual line toward surroundings, which is a cause of an accident with a vehicle, an obstacle or the like. As vehicles excellent in silence such as hybrid cars and electrical cars increase, more pedestrians are in danger of having accidents with these vehicles. In this regard, a technology that automatically prevents the user watching the screen of a mobile terminal from having an accident or being in danger is known.

However, the conventional technology that automatically prevents a user from having accidents or being in danger changes the operation status of a running application in accordance with the relation between the application and user's status without determining whether the user actually may have an accident or is in danger. Thus, the technology occasionally suppresses user's usage of a mobile terminal even in the case where the user is not in danger. Because of this, the technology is low in convenience for a user.

SUMMARY OF THE INVENTION

According to one aspect of the invention, a mobile terminal includes a display screen, a first camera that is installed on a side of the mobile terminal having the display screen, a velocity sensor that derives moving velocity of the mobile terminal, and a controller configured to (i) determine a starting state of the display screen, (ii) determine a direction of a face of a user based on a shot image obtained from the first camera, and (iii) determine whether the user is walking while watching the mobile terminal based on the moving velocity, the starting state and the direction of the face of the user.

This can surely determine that the user is walking while watching the mobile terminal and is in danger, and can notify the user of being danger, if applicable.

According to another aspect of the invention, a danger notifying system notifies a driver of a vehicle that a user of a mobile terminal is in danger, and includes the mobile terminal and the vehicle. On the danger notifying system, the mobile terminal has a controller that determines (i) whether the user is walking while watching the mobile terminal and (ii) whether the user is in danger when the user is walking while watching the mobile terminal, a location information receiver that obtains location information of the mobile terminal, and a transmitter that transmits the location information of the mobile terminal to the vehicle when the user is in danger. In addition, the vehicle has a display that displays the location information obtained from the mobile terminal.

This can notify the driver of the vehicle that a pedestrian in danger exists in the periphery, if any.

Therefore, the object of the invention is to provide the technology that can accurately determine user's status, and can notify the user in danger when the user is in danger.

These and other objects, features, aspects and advantages of the invention will become more apparent from the following detailed description of the invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a schematic configuration of a danger notifying system.

FIG. **2** shows a configuration block diagram of a mobile terminal.

FIG. **3** shows a configuration block diagram of a vehicle.

FIG. **4** shows a configuration block diagram of a center.

FIG. **5** shows a flowchart of danger notifying processing.

FIG. **6** shows a flowchart of walking state determining processing.

FIG. **7** shows a flowchart of danger determining processing.

FIG. **8** shows a flowchart of danger degree determining processing.

FIG. **9** shows a flowchart of notification processing.

FIG. **10** shows an example of a display screen.

FIG. **11** shows another example of a display screen.

FIG. **12** shows another flowchart of danger determining processing.

FIG. **13** shows another flowchart of danger degree determining processing.

DESCRIPTION OF THE EMBODIMENTS

Hereinafter, some embodiments of the invention are described with reference to drawings.

1. First Embodiment

<1-1. System Outline>

FIG. **1** shows a schematic configuration of a danger notifying system **100** of the embodiment. The danger notifying system **100** has a mobile terminal **10**, a vehicle **30** and a center **40**.

The mobile terminal **10** is a mobile electronic device carried by a user, for example, a smartphone, a tablet, a mobile phone and PDA (Personal Digital Assistant). The mobile terminal **10** has a function for notifying the user that the user is in danger in the case where the user is in danger of having an accident or others. The mobile terminal **10** determines whether the user is in danger or not, in consideration of user's status and surroundings. When determining that the user is in danger, the mobile terminal **10** notifies the user of details in accordance with the degree of danger. The mobile terminal **10** is constituted so as to be communicable with the center **40**, and transmits location information or others of the mobile terminal **10** that is in danger.

The vehicle **30** is a vehicle, for example a car, running in the periphery of the user. The vehicle **30** outputs ultrasonic waves having a prescribed frequency to notify the mobile terminal **10** in the periphery of the existence of the vehicle. The vehicle **30** is constituted so as to be communicable with the center **40**. When receiving from the center **40** the location information of the mobile terminal **10** that is in danger, the vehicle **30** displays the contents of the received information on a display.

The center **40** is an information processor that is constituted so as to be communicable with the mobile terminal **10** and the vehicle **30**. When receiving the location information from the mobile terminal **10** that is in danger, the center **40** transmits the information to the vehicle **30**.

As above, the mobile terminal **10** of the embodiment determines whether the user is in danger or not, in consideration of the status of the user using the mobile terminal **10** and the

status of the vehicle **30** running in the periphery of the user. Then, the mobile terminal **10**, when determining that the user is in danger, notifies the user of the determination result. In addition, the danger notifying system **100** is capable of notifying the vehicle **30** of the existence of the mobile terminal **10** that is in danger. Hereinafter, respective configurations and processing of the danger notifying system **100** are detailed.

<1-2. Configuration of Mobile Terminal>

First, the configuration of the mobile terminal **10** is described. FIG. **2** shows a schematic block diagram of the mobile terminal **10**. As shown in FIG. **2**, the mobile terminal **10** has a controller **11**, an acceleration sensor **12**, a display **13**, a first photographing part **14**, a second photographing part **15**, a time measuring part **16**, a location information acquisition part **17**, a sound output part **18**, a sound collector **19**, an operation part **20**, a memory **21**, and a communicator **22**.

Further, the controller **11** is a computer having a walking state determining part **11***a*, a danger determining part **11***b*, a danger degree determining part **11***c* and a notification controller **11***d*, and also having a CPU, RAM and ROM not shown in the figure. The controller **11** that is connected to the memory **21** and others included in the mobile terminal **10** controls the entire mobile terminal **10** based on a program **21***a* stored in the memory **21**. Execution of arithmetic processing by the CPU based on the program **21***a* stored in the memory **21** provides various functions of the controller **11**.

The walking state determining part **11***a* determines whether the user is walking while watching the mobile terminal **10**. In this specification, user's act of walking while watching the mobile terminal **10** is called "while-watching walking." That is, the walking state determining part **11***a* determines whether the user is in the state of "while-watching walking" or not. The walking state determining part **11***a* determines whether the user is in the "while-watching walking" state based on moving velocity of the mobile terminal **10** (that is user's moving velocity), a starting state (on or off of a screen) of the display **13** and others.

When the user is in the "while-watching walking" state, the danger determining part **11***b* determines whether the user is in danger of having a contact accident with a car or the like. The danger determining part **11***b* obtains the information of the vehicles and the like running in the periphery of the point of the user being in the "while-watching walking" state, and determines whether the user is in danger based on the information.

The danger degree determining part **11***c* determines user's danger degree when the user is in danger. Even the user is in danger, user's danger degree may vary in accordance with user's use status on the mobile terminal **10**. Thus, the danger degree determining part **11***c* determines user's danger degree from plural danger levels in consideration of the information.

The notification controller **11***d* notifies, when the user is in danger, the user that he or she is in danger. The notification controller **11***d* notifies the user that he or she is in danger, by displaying such a message on the display **13** or outputting such message sound through the sound output part **18**. The notification controller **11***d* selects an applicable message or sound for notification out of plural types of messages and sounds in accordance with the danger degree.

The acceleration sensor **12** derives acceleration while the mobile terminal **10** moves. In the embodiment, the acceleration sensor **12** that may be a two-axial acceleration sensor or a three-axial acceleration sensor integrates the acceleration in a horizontal direction to derive the moving velocity of the mobile terminal **10** (that is user's moving velocity).

The display **13** is displaying apparatus installed in the mobile terminal **10**, for example, a liquid crystal display or an organic EL display.

Each of the first photographing part **14** (the first camera) and the second photographing part **15** (the second camera) which is constituted with a camera including a lens and an imaging device, electronically obtains images where the periphery of the mobile terminal **10** is photographed. The first photographing part **14** is installed on the side of the display **13** of the mobile terminal **10** to capture the peripheral images of the side of the display **13**. The second photographing part **15** is installed on the opposite side to the display **13** of the mobile terminal **10** to capture the peripheral images of the opposite side to the display **13**. That is, the first photographing part **14** is a so-called inward camera to capture user's side in a normal use. The second photographing part **15** is a so-called outward camera to capture the opposite side to the user in a normal use.

The time measuring part **16** measures time, for example, the time during which the user is watching the display **13** so as to use the time for determining whether the user is in the "while-watching walking" state.

The location information acquisition part **17** obtains the location information of the mobile terminal **10**. The location information acquisition part **17** may use, for example, GPS (Global positioning system). The location information of the mobile terminal **10** obtained by the location information acquisition part **17** includes latitude information and longitude information. That is, the location information acquisition part **17** obtains the latitude information and the longitude information of the current location of the mobile terminal **10** by use of GPS.

The sound output part **18** is the part that outputs music and voices when playing music and videos on the mobile terminal **10**, for example, a speaker or an earphone output part.

The sound collection part **19** is the part that collects exterior sound for input to the mobile terminal **10**, for example, a microphone. The sound collector **19** of the embodiment is constituted so as to be able to collect not only the sound having frequencies in an audible range but the sound in an inaudible range such as ultrasonic waves.

The operation part **20** is input apparatus equipped with a touch panel. The user can carry out various operations on the mobile terminal **10** by operating the operation part **20**.

The memory **21** stores the program **21***a* and map information **21***b*. The memory **21** of the embodiment is nonvolatile semiconductor memory where data reading and writing are electrically available and that is capable of keeping data even in a power-off state. For example, EEPROM (Electrical Erasable Programmable Read-Only memory) or a flash memory may be used as the memory **21**. However other memory media or a hard disk drive including a magnetic disk may be also used.

The program **21***a* is so-called system software that is read out by the controller **11** for execution to control the mobile terminal **10**. The map information **21***b* includes road information around the country or of a predetermined wide area.

The communicator **22** is constituted so as to be able to communicate with the center **40** for exchanging information with the center **40**. In an example, the communicator **22** transmits to the center **40** the location information of the mobile terminal **10** that is in danger. Communication between the mobile terminal **10** and the center **40** is through a so-called mobile telephone network, or Internet line.

<1-3. Configuration of Vehicle>

Next, the configuration of the vehicle **30** is described. FIG. **3** shows a schematic block diagram of the vehicle **30**. As shown in FIG. **3**, the vehicle **30** has a controller **31**, an ultra-

sonic wave output part **32**, a vehicle information acquisition part **33**, a memory **34**, a communicator **35** and a display **36**.

The controller **31** that includes an ultrasonic wave output controller **31***a* is a computer that has a CPU, RAM and ROM not shown in the figure. The controller **31** that is connected to the memory **34** and others controls the entire vehicle **30** based on a program **34***a* that is stored in the memory **34**. Execution of arithmetic processing by the CPU based on the program **34***a* stored in the memory **34** provides various functions of the controller **31**.

The ultrasonic wave output controller **31***a* controls the ultrasonic waves having a prescribed frequency that are to be output outside the vehicle **30** through the ultrasonic wave output part **32** to be described later.

The controller **31** is connected so as to be able to communicate to other various sensors and ECUs (Electronic Control Units) installed in the vehicle via an on-vehicle LAN (Local Area Network) such as a CAN (Controller Area Network) for exchanging various types of information with these sensors and ECUs.

The ultrasonic wave output part **32** outputs ultrasonic waves having a prescribed frequency so as to notify its surroundings that the vehicle exists. The ultrasonic waves output by the ultrasonic wave output part **32** have a frequency collectable by the sound collector **19**. Thus, the mobile terminal **10** can detect that a vehicle exists in the periphery or is approaching by obtaining the ultrasonic waves output by the ultrasonic wave output part **32**.

The vehicle information acquisition part **33** obtains vehicle information as the information indicating the running conditions of the vehicle and the conditions of other ECUs. A vehicle is equipped with: sensors to detect running vehicle conditions, such as a vehicle velocity sensor and a steering angle sensor; engine-control-type ECUs such as a fuel injection ECU; and body-control-type ECUs such as a door-lock/-unlock ECU. The vehicle information acquisition part **33** obtains the output by these sensors and ECUs via CAN as vehicle information.

The memory **34** stores the program **34***a*. The memory **34** of the embodiment is nonvolatile semiconductor memory where data reading and writing are electrically available and that is capable of keeping data even in a power-off state. For example, EEPROM or a flash memory may be used as the memory **34**. However, other memory media or a hard disk drive including a magnetic disk may be also used. The program **34***a* is so-called system software that is read out for execution to control the vehicle **30**.

The communicator **35** is constituted so as to be able to communicate with the center **40** for exchanging information with the center **40**. In an example, the communicator **35** receives from the center **40** the location information of the mobile terminal **10** that is in danger. Communication between the vehicle **30** and the center **40** may be through a so-called mobile telephone network or Internet line.

The display **36** is displaying apparatus installed in the vehicle **30**, for example, a liquid crystal display and an organic EL display. The display **36** displays the location information of the mobile terminal **10** that is in danger, which has been obtained from the center **40**.

<1-4. Configuration of Center>

Next, the configuration of the center **40** is described. FIG. **4** shows a schematic block diagram of the center **40**. As shown in FIG. **4**, the center **40** has a controller **41**, a communicator **42** and a memory **43**.

The controller **41** is a computer that has a CPU, RAM and ROM not shown in the figure. The controller **41** that is connected to the memory **43** and others included in the center **40** controls the entire center **40** based on a program **43***a* stored in the memory **43**. Execution of arithmetic processing by the CPU based on the program **43***a* stored in the memory **43** provides various functions of the controller **41**.

The communicator **42** is constituted so as to be able to communicate with the mobile terminal **10** and with the vehicle **30** for exchanging information with them respectively. In an example, the communicator **42** receives the location information of the mobile terminal **10** that is in danger from the mobile terminal **10**, and then transmits the received location information to the vehicle **30**. Communication between the mobile terminal **10** and the center **40** and between the vehicle **30** and the center **40** is through a so-called mobile telephone network or Internet line.

The memory **43** stores the program **43***a* and danger information **43***b*. The memory **43** is nonvolatile semiconductor memory where data reading and writing are electrically available and that is capable of keeping data even in a power-off state. For example, EEPROM or a flash memory may be used as the memory **43**. However, other memory media or a hard disk drive including a magnetic disk may be also used.

The program **43***a* is so-called system software that is read out by the controller **41** for execution to control the center **40**. The danger information **43***b* includes the location information of the mobile terminal **10** that is in danger, which has been obtained from the mobile terminal **10**.

<1-5. Processing on Mobile Terminal>

Next, processing on the mobile terminal **10** is described. Each of FIG. **5**, FIG. **6**, FIG. **7**, FIG. **8** and FIG. **9** shows processing on the mobile terminal **10**.

FIG. **5** shows an outlined flowchart of danger notifying processing executed by the mobile terminal **10**. As shown in FIG. **5**, the mobile terminal **10** first executes walking state determining processing (step **S501**). That is, the mobile terminal **10** detects user's status and use status on the mobile terminal **10**, and determines whether the user is walking while watching the mobile terminal **10** (in the while-watching walking state).

When determining that the user is in the while-watching walking state, the mobile terminal **10** executes danger determining processing (step **S502**). Even when the user is walking while watching the mobile terminal **10**, in some case of user's surroundings the user is not in danger. Thus, the mobile terminal **10** determines whether the user is in danger where the user may have an accident or the like.

When determining that the user is in danger, the mobile terminal **10** executes danger degree determining processing (step **S503**). That is, when determining that the user is in danger, the mobile terminal **10** determines a danger degree (level of danger) in accordance with a situation. The purpose of this processing is to change a notifying method to the user in accordance with the danger degree: high or low. The danger degree is determined in consideration of the relationship between the user and a vehicle, use status on the mobile terminal **10** and others.

After determining the danger degree, the mobile terminal **10** executes notification processing (step **S504**). That is, the mobile terminal **10** notifies the user that the user is in danger. The method and details of the notification vary in accordance with the danger degree. In an example, a message giving notification of danger is displayed in a small size on an upper part of a screen, displayed in a large size on the middle of a screen, or output by voice. Moreover, these may be combined.

Next, each processing (step **S501** to step **S504**) in the danger notifying processing described so far is detailed.

FIG. **6** shows a flowchart of the walking state determining processing (step **S501**). The walking state determining pro-

cessing starts when the mobile terminal **10** is activated. However, the processing may start when a screen is lit on (when a screen is turned on). As shown in FIG. **6**, when the walking state determining processing starts, the mobile terminal **10** first determines whether user's moving velocity substantially corresponds to a human walking speed (step **S601**).

Concretely, the walking state determining part **11***a* first periodically obtains output values from the acceleration sensor **12**, and derives the moving velocity of the mobile terminal **10** based on the obtained acceleration. Since the acceleration sensor **12** is a two-axial sensor or a three-axial acceleration sensor as described above, the output acceleration includes at least acceleration in a horizontal direction. The walking state determining part **11***a* derives the moving velocity of the mobile terminal **10** by executing arithmetic processing such as integration to the acceleration of a horizontal direction obtained from the acceleration sensor.

Then, the walking state determining part **11***a* determines whether the moving velocity of the mobile terminal **10** substantially corresponds to a human walking speed. The moving velocity of the mobile terminal **10** is, in other words, user's moving velocity. That is, through the determination whether the derived moving velocity of the mobile terminal **10** substantially corresponds to human moving velocity, the walking state determining part **11***a* can determine whether the user is moving at a walking speed (that is, whether the user is walking). Here, the human walking speed is, for example, from 2 km/h to 6 km/h.

In the case where the user is not moving at the walking speed (No at the step **S601**), the walking state determining part **11***a* determines that the user is not in the while-watching walking state (step **S609**), and then turns off a while-watching walking determination flag (step **S610**). Then, the mobile terminal **10** ends the danger notifying processing. Here, the while-watching walking determination flag is on (the flag is set) while the user is in the while-watching walking state, and off (the flag is deleted) while the user is not in the while-watching walking state.

On the other hand, when the user is moving at the walking speed (Yes at the step **S601**), the walking state determining part **11***a* determines whether the screen is on (step **S602**). Even while the mobile terminal **10** is in an activated state and the user is moving at the walking speed, the user is walking but not while watching the screen when the screen light is off. Therefore, the walking state determining part **11***a* determines whether the screen light is on.

When the screen is not on (No at the step **S602**), the walking state determining part **11***a* determines that the user is not in the while-watching walking state (step **S609**), and turns off the while-watching walking determination flag (step **S610**). Then, the mobile terminal **10** ends the danger notifying processing.

On the other hand, when the screen is on (Yes at the step **S602**), the walking state determining part **11***a* determines whether user's face is toward the screen (step **S603**). When the walking state determining processing is started, the first photographing part **14** starts and periodically captures images. As the first photographing part **14** is a so-called inward camera as indicated above, while the user is watching the screen, user's face is photographed.

The walking state determining part **11***a* recognizes a face included in an image captured by the first photographing part **14** by use of a face recognition algorithm or the like, and a face direction. The walking state determining part **11***a* can recognize the face direction, for example, by extracting face data out of the image captured by the first photographing part **14** based on the relative position and sizes of face parts or others.

The walking state determining part **11***a* determines based on the recognition result whether user's face is toward the screen. The walking state determining part **11***a* determines that user's face is toward the screen when the recognized face direction is toward the screen.

When user's face is not toward the screen (No at the step **S603**), the walking state determining part **11***a* determines that the user is not in the while-watching walking state (step **S609**), and turns off the while-watching walking determination flag (step **S610**). Then, the mobile terminal **10** ends the danger notifying processing.

When user's face is toward the screen (Yes at the step **S603**), the walking state determining part **11***a* determines whether user's visual line is toward the screen (step **S604**). Even while user's face is toward the screen, the user is walking but not while watching the mobile terminal **10** while user's visual line is not toward the screen. Thus, the walking state determining part **11***a* determines whether user's visual line is toward the screen.

The walking state determining part **11***a* can use a visual line recognition algorithm or the like to recognize as the direction of a visual line the extension line connecting the center position of user's iris and the center position of user's eyeball in an image captured by the first photographing part **14**. Concretely, the walking state determining part **11***a* extracts an image corresponding to user's eye out of an image captured by the first photographing part **14**, and further extracts an iris out of the image showing eyes. Then, the walking state determining part **11***a* recognizes the direction of the visual line by detecting the center position of the iris, and driving the line connecting the center position of the iris and the center position of the eyeball. The walking state determining part **11***a* determines whether user's visual line is toward the screen based on the recognition result. The walking state determining part **11***a* determines that user's visual line is toward the screen when the recognized direction of the visual line is toward the screen.

One of the step **S603** and the step **S604** may be executed. Executing just one of the steps is enough to roughly determine whether the user is watching the screen. However, executing the both steps as in the embodiment provides more accurate determination on whether the user is watching the screen.

Next, while user's visual line is not toward the screen (No at the step **S604**), the walking state determining part **11***a* determines that the user is not in the while-watching walking state (step **S609**), and turns off the while-watching walking determination flag (step **S610**). Then, the mobile terminal **10** ends the danger notifying processing.

While user's visual line is toward the screen (Yes at the step **S604**), the walking state determining part **11***a* determines whether the time during which user's visual line is toward the screen has continued for a prescribed period of time (step **S605**). Even while the user is walking while watching the mobile terminal **10**, it is not said that the user is in the dangerous while-watching walking state when the user moves his or her visual line from the screen in a short time. Accordingly, criteria for determining of the while-watching walking state include the item that the time during which a user is watching a screen has continued for a prescribed period of time or longer.

When the walking state determining processing is started, the time measuring part **16** is activated. The time measuring part **16** measures the time from when it is determined that user's visual line is toward the screen to when it is determined that user's visual line is not toward the screen. The walking state determining part **11***a* obtains the time information from the time measuring part **16**, and determines whether a pre-

scribed period of time has elapsed since the measurement start. The case where a prescribed period of time has elapsed is, in other words, the case where the time during which the user is watching the screen has continued for a prescribed period of time.

When the time during which the user is watching the screen has not continued for a prescribed period of time (No at the step **S605**), the walking state determining part **11***a* determines that the user is not in the while-watching walking state (step **S609**), and turns off the while-watching walking determination flag (step **S610**). Then, the mobile terminal **10** ends the danger notifying processing.

When the time during which the user is watching the screen has continued for a prescribed period of time (Yes at the step **S605**), the walking state determining part **11***a* determines whether a background is changing (step **S606**). The background is the scene photographed by the second photographing part **15**. When the walking state determining processing is started, the second photographing part **15** starts and periodically captures images. Since the second photographing part **15** is an outward camera as described above, the second photographing part **15** photographs the ground where the user is located while the user holds the mobile terminal **10** substantially horizontally.

While the user is walking, the background is changing accordingly. Thus, the walking state determining part **11***a* determines whether the background is changing. Whether the background is changing may be determined based on the determination whether feature points on captured images (for example, luminance distribution information) move, expand or shrink. Therefore, the walking state determining part **11***a* determines whether there is any change in the background among the images captured periodically and successively.

While the user is on a train or a vehicle such as a car that is moving at a low speed, in each of the steps from the step **S601** to the step **S605**, the determination that the user is in the while-watching walking state may be made. However, the background is not changing while the user is on a train, a car or other vehicle. Thus, using the determining criteria including the determination whether the background is changing as indicated in the embodiment allows accurate distinction of the walking state from the moving state on a vehicle.

While the background is not changing (No at the step **S606**), the walking state determining part **11***a* determines that the user is not in the while-watching walking state (step **S609**), and turns off the while-watching walking determination flag (step **S610**). Then, the mobile terminal **10** ends the danger notifying processing.

While the background is changing (Yes at the step **S606**), the walking state determining part **11***a* determines that the user is in the while-watching walking state (step **S607**), and turns on the while-watching walking determination flag (step **S608**). That is, the walking state determining part **11***a* determines that the user is in the while-watching walking state when all of the criteria from the step **S601** to the step **S606** are satisfied.

Whether the user is in the while-watching walking state may be determined based on the determination on the steps from the step **S601** to the step **S603**. However, the while-watching walking state may be accurately determined based on the entire determination criteria including the change in background and others, in addition to the criteria concerning the moving velocity, user's face direction and the direction of user's visual line as in the embodiment. Then, the mobile terminal **10** advances the processing to the danger determining processing (step **S502**).

Next, the danger determining processing (step **S502**) is detailed. FIG. **7** shows the flowchart of the danger determining processing.

First, the danger determining part **11***b* determines whether the while-watching walking determination flag is on (step **S701**). If the danger determining processing is executed only when it is determined that the user is in the while-watching walking state, this step can be omitted. However, since it is possible to concurrently execute the walking state determining processing and the danger determining processing, the while-watching walking determination flag may be off when the danger determining processing starts in some processing execution timings. Thus, in the danger determining processing, it is checked that the while-watching walking determination flag is on.

When the while-watching walking determination flag is off (No at the step **S701**), the danger determining part **11***b* determines that the user is not in danger (step **S704**), and ends the danger notifying processing.

When the while-watching walking determination flag is on (Yes at the step **S701**), the danger determining part **11***b* determines whether any vehicle is approaching (step **S702**). Even while the user is in the while-watching walking state, the user may not be in danger, for example, in the case where there is no vehicle running around the user. Thus, the danger determining part **11***b* determines whether the user is in danger in consideration of user's surroundings, for example, the existence of any approaching vehicle.

Here, the method to determine whether any vehicle is approaching is described. The vehicle **30** is running while outputting ultrasonic waves that have a prescribed frequency from the ultrasonic wave output part **32**. The prescribed frequency can be any frequency that the sound collector **19** of the mobile terminal **10** can collect, for example, any frequency from 20 kHz to 40 kHz.

When the sound collector **19** of the mobile terminal **10** receives the ultrasonic waves, the danger determining part **11***b* converts the received ultrasonic waves to frequency components by FFT (Fast Fourier Transform) or other processing. The danger determining part **11***b* periodically executes this processing to determine whether any vehicle is approaching based on the change in the frequency. That is, assuming that the frequency of the ultrasonic waves output from the ultrasonic wave output part **32** of the vehicle **30** is constant, the frequency of the ultrasonic waves received by the mobile terminal **10** gradually increases as a vehicle is approaching (due to Doppler effect).

Accordingly, the danger determining part **11***b* determines that a vehicle is approaching when the frequency of the ultrasonic waves changes toward a high frequency side more than a prescribed number of times repeatedly. The purpose of setting a prescribed number of times as a condition is to accurately extract an approaching vehicle, while excluding an inapplicable vehicle, for example, a vehicle once approaching but going away in a short time. The number of times just enough to make accurate determination of approaching may be appropriately set, for example, three times, five times, and ten times.

When there is no approaching vehicle in the step **S702** (No at the step **S702**), the danger determining part **11***b* determines that the user is not in danger (step **S704**), and ends the danger notifying processing.

When a vehicle is approaching (Yes at the step **S702**), the danger determining part **11***b* determines that the user is in danger (step **S703**). As above, considering not only user's while-watching walking state but also user's surroundings (especially an approaching vehicle) allows the extraction of

the case where the user is in danger. Then, the mobile terminal **10** advances the processing to the danger degree determining processing (step S**503**).

Next, the danger degree determining processing (step S**503**) is detailed. FIG. **8** shows the flowchart of the danger degree determining processing.

First, the danger degree determining part **11***c* determines a danger degree based on relative velocity to the vehicle **30** (step S**801**). The relative velocity to the vehicle **30** is derived based on the change in frequency of the ultrasonic waves collected from the vehicle **30**. In the embodiment, the danger degree is determined in a manner where the range of the relative velocity is divided into, for example, two: when the relative velocity is larger, the danger degree is higher; and the relative velocity is smaller, the danger degree is lower. How to distinguish between larger velocity and smaller velocity can be appropriately set. In an example, relative velocity of 20 km/h or higher corresponds to larger velocity; and relative velocity of less than 20 km/h corresponds to smaller velocity.

Then, the danger degree determining part **11***c* determines the danger degree based on a distance to the vehicle **30** (step S**802**). In an example case where the vehicle **30** is constituted so as to superimpose the location information of the vehicle **30** itself on ultrasonic waves for output, the mobile terminal **10** can derive the distance to the vehicle **30** by comparing the received location information and its own location information. In this case, the danger degree determining part **11***c* determines the danger degree in a manner where the range of the relative distance is divided into, for example, two: when the distance is shorter, the danger degree is higher; and when the distance is longer, the danger degree is lower. How to distinguish between shorter distances and longer distance can be appropriately set. In an example, a distance shorter than 50 m corresponds to a shorter distance; a distance of 50 m or longer corresponds to a longer distance.

Then, the danger degree determining part **11***c* determines the danger degree based on whether application highly involving gazing is running or not (step S**803**). The application highly involving gazing is the application at which the user highly possibly stares in the screen, for example, video playback application or game application. The danger degree determining part **11***c* determines whether the application currently used corresponds to the application highly involving gazing based on the category (e.g., video, game) assigned to each application, to determine the danger degree in a manner where: when the application corresponds to the application highly involving gazing, the danger degree is high; and when the application corresponds to the application not-involving gazing, the danger degree is low.

Next, the danger degree determining part **11***c* determines the danger degree based on whether there is any earphone output (step S**804**). The danger degree determining part **11***c* determines whether any sound is output from an earphone output terminal included in the sound output part **18**, to determine the danger degree in a manner where: when any sound is output, the danger degree is high; and when no sound is output, the danger degree is low. The case where any sound is output from an earphone output terminal is when the user is listening to the music, video sound or others by use of an earphone, not listening to the sound of surroundings. Thus, sine the user can not listen to any approaching sound of a vehicle or others and accordingly the user hardly realizes an approaching vehicle, the danger degree is set to be higher.

The danger degree determining part **11***c* determines, based on the danger degrees determined by these steps of the determination processing, a comprehensive danger degree to select the details notifying the user of danger (hereinafter, referred to as "comprehensive danger degree") (step S**805**). In an example in the embodiment, when two or more items are determined as high danger degree in the steps of the processing, the comprehensive danger degree is set to be high; when one item is determined as high danger degree, the comprehensive danger degree is set to be middle; and when non is determined as high danger degree, the comprehensive danger degree is set to be low.

However, the method for determining the comprehensive danger degree is not limited to this. The range of the comprehensive danger degree may be divided into three or more, or the number of the items as high danger degree for classifying the comprehensive danger degree may be changed. Or, the comprehensive danger degree is determined only based on a specific danger degree. The comprehensive danger degree can be appropriately set in accordance with the details of the danger degrees determined in the respective steps or with their combination. Based on a table showing the relation between various danger degrees and the comprehensive danger degree previously stored in the memory **21**, the danger degree determining part **11***c* may determine the comprehensive danger degree. As above, the danger degree to select the details for notifying the user of danger is determined. Then, the mobile terminal **10** advances the processing to the notification processing (step S**504**).

Next, the notification processing (step S**504**) is detailed. FIG. **9** shows the flowchart of the notification processing.

First, the notification controller **11***d* selects notification details based on the comprehensive danger degree (step S**901**). The notification details are the types and details of a message, an icon, vibration, a voice and others, to notify the user that he or she is in danger. The notification controller **11***d* selects one type or plural types out of these various types in accordance with the comprehensive danger degree. In an example, when the comprehensive danger degree is high, the notification controller **11***d* selects a message, vibration and a voice; when the comprehensive danger degree is middle, the notification controller **11***d* selects an icon and vibration; and when the comprehensive danger degree is low, the notification controller **11***d* selects only an icon.

Then the notification controller **11***d* notifies the user that the user is in danger based on the selected notification details (step S**902**). When using a message for notifying the user of danger, the notification controller **11***d* displays an interruption pop-up message on the screen displayed at the time in the display **13**. When using an icon for notifying the user of danger, the notification controller **11***d* displays an icon at a prescribed position such as the upper part of the screen of the display **13**.

Here is an example of a message displayed on the screen by the notification controller **11***d* for explanation. Each of FIG. **10** and FIG. **11** shows an example of the screen for notifying the user of danger. As shown in FIG. **10**, when using a message for notifying the user of danger, the notification controller **11***d* displays an interruption message on the screen. When using an icon for notifying the user of danger, as shown in FIG. **11**, the notification controller **11***d* displays an icon at a prescribed position of the screen.

When using vibration for notifying the user of danger, the notification controller **11***d* vibrates the mobile terminal **10** for a prescribed period of time. When using a voice for notifying the user of danger, the notification controller **11***d* outputs a voice telling the danger from the sound output part **18**. In the case where the user is using an earphone, the notification controller **11***d* outputs an interruption voice from an earphone output terminal over the sound output at the time. When the user is not using an earphone, the notification controller **11***d*

outputs the voice from a speaker. The notification controller **11***d* outputs for notification a voice such as "a vehicle is approaching" from an earphone output terminal or a speaker. This notifies the user of danger in accordance with a danger degree.

As above, the mobile terminal **10** determines whether the user is in danger or not in consideration of the status of surroundings and the use status on the mobile terminal **10** while the user is in the while-watching walking state. Then, the mobile terminal **10** determines whether notifying the user of danger is required and changes the notification details in accordance with the determination result. As above, the processing ensures to determine that the user is in the while-watching walking state and that the user is in danger, and to notify the user of the details in accordance with user's danger degree.

<1-6. Processing of Danger Notifying System>

The invention can also notify a driver on the vehicle **30** of danger in addition to notifying the user of the mobile terminal **10** of danger. The description hereafter is about the danger notification given to the driver on the vehicle **30**.

On the danger notifying system **100**, the mobile terminal **10** transmits to the center **40** the location information of the mobile terminal **10** when the user is in danger. Concretely, the mobile terminal **10**, when it is determined that the user is in danger in the danger determining processing, transmits the determination result and the location information (these are called "danger information") to the center **40**. Then, the center **40** collects the danger information and transmits the collected danger information to the vehicle **30** running in the periphery of the mobile terminal **10** that is in danger.

The vehicle **30**, when receiving the danger information from the center **40**, displays the danger information on the display **36**, that is, displays at an applicable location on a map the indication of existence of the mobile terminal **10** that is in danger. This notifies the driver on the vehicle **30** about existence of a pedestrian with declined concentration to surroundings, so as to make the driver pay attention.

2. Second Embodiment

Next, the second embodiment is described. In the configuration of the first embodiment, danger is determined in consideration of whether there is any vehicle approaching in the periphery of a user. In another configuration, danger is determined in consideration of an obstacle other than a vehicle. In the second embodiment, the configuration where danger is determined in consideration of an obstacle other than a vehicle is described.

<2-1. Outline of System>

A danger notifying system of the second embodiment has the same configuration as the danger notifying system **100** shown in FIG. **1**. That is, the configuration of a mobile terminal **10**, a vehicle **30** and a center **40** of the second embodiment are the same as those of the first embodiment. In the second embodiment, danger determining processing and danger degree determining processing out of the danger notifying processing by the mobile terminal **10** are different from those of the first embodiment. Thus, hereafter the different points from the first embodiment regarding the danger notifying processing are mainly described.

<2-2. Danger Notifying Processing>

The danger notifying processing of the second embodiment is described. The outline of the danger notifying processing of the second embodiment is the same as the one of the first embodiment. That is, the mobile terminal **10** executes the danger determining processing (walking state determining processing, danger determining processing, danger degree determining processing and notification processing) shown in FIG. **5**. In the danger notifying processing of the embodiment, the walking state determining processing and the notification processing are the same as the ones of the first embodiment; while the danger determining processing and the danger degree determining processing are different from the ones of the first embodiment.

First, the danger determining processing of the embodiment is described. FIG. **12** shows the flowchart of the danger determining processing.

First, a danger determining part **11***b* determines whether a while-watching walking determination flag is on (step **S1201**). This is the same step as the step **S701** described above. When the while-watching walking determination flag is off (No at the step **S1201**), the danger determining part **11***b* determines that a user is not in danger (step **S1205**), and ends the danger notifying processing to be executed by the mobile terminal **10**. This is also the same step as the step **S704** described above.

When the while-watching walking determination flag is on (Yes at the step **S1201**), the danger determining part **11***b* determines whether there is any obstacle (step **S1202**). The user may, even while walking on a pavement, have an accident with an obstacle on the pavement. Thus, the danger determining part **11***b* determines whether the user is in danger in consideration of the obstacle by determining the existence of any obstacle with which the user may have an accident.

Here is the description about the method for determining the existence of any obstacle. The mobile terminal **10** keeps a second photographing part **15** activated even during execution of the danger determining processing so as to periodically capture images. The danger determining part **11***b* determines the existence of an obstacle based on the determination whether any obstacle is included in shot images. The obstacle is an object with which the user may have an accident, for example, a telegraph pole and a baby buggy, further including a place where the user may fall, for example, the end of station's platform.

In an example, a memory **21** stores the patterns of obstacles such as telegraph poles and others in advance, and the danger determining part **11***b* compares the object or others extracted by image recognition with the stored patterns of obstacles to determine whether the object is an obstacle in accordance with coincidence. The danger determining part **11***b*, when determining that the object is an obstacle, determines that there is an obstacle.

At the step **S1202**, when there is no obstacle (No at the step **S1202**), the danger determining part **11***b* determines that the user is not in danger (step **S1205**), and ends the danger notifying processing.

When there is an obstacle (Yes at the step **S1202**), the danger determining part **11***b* determines whether user's visual line is toward a screen (step **S1203**). When user's visual line is toward a screen, it is highly possible that the user is not aware of the obstacle. Thus, the determination is included in the conditions for determining danger state. Whether user's visual line is toward the screen is determined by the same method as the step **S604** described above.

When user's visual line is not toward the screen (No at the step **S1203**), the danger determining part **11***b* determines that the user is not in danger (step **S1205**), and ends the danger notifying processing. When user's visual line is toward the screen (Yes at the step **S1203**), the danger determining part **11***b* determines that the user is in danger (step **S1204**), and advances the processing to the danger degree determining processing (step **S503**).

The danger determining processing of the invention may be constituted so as to execute the both of the processing for determining the existence of any obstacle described in the embodiment, and the processing for determining whether any vehicle is approaching described in the first embodiment (step **S702**), and to determine that the user is in danger when one of the determining conditions is satisfied.

Next, the danger degree determining processing is described. FIG. **13** shows the flowchart of the danger degree determining processing of the embodiment.

First, a danger degree determining part **11***c* determines a danger degree based on relative velocity to the obstacle (step **S1301**). The relative velocity to the obstacle is derived based on the moving velocity of the mobile terminal **10** when the obstacle is a static object such as a telegraph pole. When the obstacle is a moving object such as a baby buggy, the danger degree determining part **11***c* derives the relative velocity by use of photographing timing and the distance to the obstacle extracted by image recognition. Then, the danger degree determining part **11***c* divides the range of the danger degree, for example, into two in accordance with the relative velocity. When the relative velocity to the obstacle cannot be derived, this step in the processing may be omitted.

Next, the danger degree determining part **11***c* determines the danger degree based on the distance to the obstacle (step **S1302**). The distance to the obstacle is derived by use of the position of the obstacle extracted by image recognition. Then, the danger degree determining part **11***c* divides the range of the danger degree, for example into two in accordance with the derived distance. When the distance to the obstacle cannot be derived, this step in the processing may be omitted.

Next, the danger degree determining part **11***c* determines the danger degree based on presence or absence of earphone output (step **S1303**). This may be made by the same step as the step **S804** described above.

Next, the danger degree determining part **11***c* determines a comprehensive danger degree to select the details for notifying the user of danger based on the danger degrees determined by these respective steps (step **S1304**). This determination may be also made by the same step as the step **S805** described above. Then, the processing moves on to the notification processing (step **S504**). In the embodiment, in the case where an obstacle is detected and it is determined that the user is in danger, one fixed danger degree may be adopted without determining the danger degree.

As above, in the case where the user is in the while-watching walking state, and in danger with possibility of having an accident with an obstacle other than a vehicle, the processing ensures to determine that the user is in the while-watching walking state and that the user is in danger, and to notify the user of the details in accordance with user's danger degree.

3. Modification

The embodiments of the invention have been described so far. However, the invention is not limited to the embodiments described above, and may provide various modifications. Hereafter, these modifications are described. All embodiments including the embodiments described above and the embodiments to be described below can be arbitrarily combined with others.

<3-1. Walking State Determination>

First, modifications of the walking state determining processing are described. In each of the embodiments described above, the mobile terminal **10** is constituted so as to activate the first photographing part **14** and the second photographing part **15** to photograph user's face and a background at constant intervals of time, when the walking state determining processing starts. However, a mobile terminal may be constituted so as to photograph them at variable intervals of time depending on user's moving velocity.

In an example, a mobile terminal **10**, when determining that a user is moving substantially at a fast walking speed (e.g., 6 km/h, or 4 steps/sec), shortens the interval of time (e.g., interval of 500 ms). When determining that a user is moving substantially at a normal walking speed (e.g., 4 km/h, or 2 steps/sec), the mobile terminal **10** lengthens the interval of time (e.g., interval of 1000 ms). This allows the mobile terminal **10** to capture images at a constant moving distance, which prevents useless consumption of a battery while making accurate determination of a walking state.

In each of the embodiments described above, the mobile terminal **10** is constituted so as to derive the moving velocity of the mobile terminal **10** by use of the output values by the acceleration sensor **12**. However, a mobile terminal may be constituted so as to derive the moving velocity by use of the location information obtained by a location information acquisition part **17**. In this case, the mobile terminal **10** can derive the moving distance based on a prescribed period of time, by obtaining the location information at a prescribed interval of time. Thus, the mobile terminal **10** can derive a moving velocity based on the period of time and the moving distance. Using a technical method such as IMES (Indoor MEssaging System) for obtaining indoor-location information as the location information acquisition part **17** allows the determination of user's moving velocity even when the user is moving indoor.

In each of the embodiments described above, a while-watching walking state is determined based on the determination condition where user's face and visual line are toward the screen for a prescribed period of time. However, a configuration is not limited to this. In an example, a user may, while using map application on a mobile terminal **10**, look around not only at a screen of the mobile terminal **10**. Thus, while map application is in a running state, walking state determining processing may be executed without the steps for determining whether user's face and visual line are toward the screen for a prescribed period of time (step **S603** to step **S605**). That is, when determining that map application is in a running state, a walking state determining part **11***a* determines that the user is in the while-watching walking state based on the determination that the conditions of the step **S601**, the step **S602** and the step **S606** are satisfied.

In each of the embodiments described above, user's moving velocity is derived based on the acceleration obtained from the acceleration sensor **12**. When the moving velocity substantially corresponds to human's walking speed, it is determined that the user is walking. However, determination processing is not limited to this. In an example, a mobile terminal **10** converts the acceleration obtained from an acceleration sensor **12** into a frequency component, and derives a period based on the frequency. The mobile terminal **10** stores the determination result of being in the walking state, and the frequency and the period at that time in the state where the determination result, the frequency and the period are associated. This allows the determination that a user is in the walking state when the acceleration of the frequency and the period specific to the user having the mobile terminal **10** is obtained. The determination conditions including these frequency and period in addition to the moving velocity offer more accurate determination that a user is in the walking state. As above, by understanding the frequency and the period corresponding to user's walking state, the mobile terminal **10** can prevent misdetermination of the user being in

the walking state, when frequency or a period does not correspond to user's walking state even with pseudo acceleration given to the mobile terminal **10**.

<3-2. Danger Determination>

Next, the modification of the danger determining processing is described. In each of the embodiments described above, the ultrasonic waves having a prescribed frequency are output from the vehicle **30**, and the danger determining part **11***b* determines that the vehicle **30** is approaching based on the change in frequency. However, the configuration is not limited to this. In an example, a vehicle **30** may be constituted so as to output ultrasonic waves with constant sound volume, and a danger determining part **11***b* may be constituted so as to determine that the vehicle **30** is approaching based on the change in the sound volume of ultrasonic waves.

Concretely, in the case where the vehicle **30** outputs ultrasonic waves with constant sound volume, the sound volume of the ultrasonic waves received by the mobile terminal **10** increases as the vehicle **30** is approaching the mobile terminal **10**. Accordingly, the danger determining part **11***b* can determine that the vehicle **30** is approaching when detecting the increase of the sound volume of the ultrasonic waves. In this case, the danger determining part **11***b* determines that the vehicle **30** is approaching when the sound volume of the ultrasonic waves increases successively more than a prescribed number of times. The reason why the determination requires more than the prescribed number of times is to ensure extraction of the vehicle **30** approaching. The number of times may be appropriately set, for example, three times, five times, and ten times.

Other than the method for determining that the vehicle **30** is approaching when the sound volume increases successively more than a prescribed number of times, the method for setting a threshold value for determining whether the vehicle **30** is approaching may be adopted. In this case, the danger determining part **11***b* determines that the vehicle **30** is approaching when the sound volume of the ultrasonic waves exceeds the threshold value. This allows the detection of the vehicle **30** approaching within the area where the user may be in danger, excluding the approach from the location far from the mobile terminal **10**.

The vehicle **30** may be constituted so as to output ultrasonic waves with variable sound volume in accordance with the velocity of the vehicle **30**, not to output ultrasonic waves with constant sound volume. In an example, the vehicle **30** may increase the sound volume of the ultrasonic waves to output as the moving velocity of the vehicle **30** increases. In this case, the mobile terminal **10** can grasp the moving velocity of the vehicle **30** and its approaching based on the sound volume of the received ultrasonic waves.

In addition to the configurations of the embodiments described above, a vehicle **30** may be constituted so as to output the information on the direction indicated by the direction indicator of the vehicle **30** and the location information of the vehicle **30**, which are superimposed on ultrasonic waves. In this case, since the mobile terminal **10** can predict the movement of the approaching vehicle **30** based on the direction information and the location information of the vehicle **30**, the mobile terminal **10** can notify the user of being in danger with the approaching direction of the vehicle **30**.

In addition to the configurations described in the embodiments, the vehicle **30** may be constituted so as to superimpose the ultrasonic waves having constant frequency of human inaudible range on the honk of the vehicle **30**. In the case where the vehicle **30** is approaching while honking, the mobile terminal **10** receives both of the ultrasonic waves output from an ultrasonic wave output part **32** and the ultrasonic waves superimposed on the honk. In an example, when a threshold value for determination of approaching is set, the mobile terminal **10** can determine earlier that the vehicle **30** is approaching.

In each of the embodiments described above, the vehicle **30** is constituted so as to constantly output ultrasonic waves. However, the configuration is not limited to this. In the case where any pedestrian never become in danger, for example, the case where there is no pedestrian around a vehicle **30** and the case where there is no possibility of contact with a pedestrian, outputting ultrasonic waves may be stopped. The case where any pedestrian never become in danger is, for example, the case where the vehicle **30** runs on an expressway, the case where the vehicle **30** is parked in a parking area, and the case where the vehicle **30** is stopped at a red signal.

In each of the embodiments described above, the vehicle **30** has the dedicated ultrasonic wave output part **32**. However, the configuration is not limited to this. In the case where an ultrasonic wave sensor (e.g. clearance sonar) for obstacle detection is installed on a vehicle **30**, the ultrasonic wave sensor may be also used as an ultrasonic wave output part by setting the frequency collectable by a sound collector **19**.

In the case where a vehicle **30** is an electric car or a hybrid car, the vehicle **30** is equipped with notification sound generating apparatus that generates a notification sound to notify the surroundings of the vehicle presence. Thus, the notification sound output by the notification sound generating apparatus may be used for determination of the approach of the vehicle **30**, instead of the ultrasonic waves output by an ultrasonic wave output part **32**. In this case, the vehicle **30** does not require a dedicated ultrasonic wave output part **32**.

When receiving the sound having the frequency that corresponds to the notification sound output by the notification sound generating apparatus, a danger determining part **11***b* determines that the vehicle **30** is approaching based on the frequency of the received notification sound, its sound volume and others. Moreover, with the use of the notification sounds having vehicle-model-specific frequencies, the danger determining part **11***b* may notify the user of the vehicle model of the approaching vehicle **30** in accordance with the frequency of the received notification sound. Thus, the user can know concretely what vehicle is approaching.

The vehicle **30** is making engine noises and road noises while running. Thus, the engine noises or the road noises may be used for determination of the approach of the vehicle **30** instead of the ultrasonic waves output from the ultrasonic wave output part **32**. In this case, the vehicle **30** can determine the approach of every type of a vehicle **30**, without installation of the dedicated ultrasonic wave output part **32** or the notification sound generating apparatus for determination of the approach of the vehicle **30**.

<3-3. Danger Degree Determination>

Next, the modification of the danger degree determining processing is described. In each of the embodiments described above, the danger degree is determined in accordance with the relative velocity or the distance to the vehicle **30**, an obstacle or others, or presence or absence of earphone output. However, the processing is not limited to this. The danger degree may be determined in consideration of other conditions.

In the case of a mobile terminal **10** connecting to a radio LAN access point, the mobile terminal **10** can identify whether the access point is located indoors or at public transportation such as a train. In the case where the mobile terminal **10** is connected to such an access point located indoors or in a train, it is highly possible that a user is not in danger such as of having a contact with a vehicle **30**. Accordingly, in the case

where the mobile terminal **10** is connected to an access point located indoors or in a train, a danger degree determining part **11***c* may determine that the danger degree is low, and may reflect the determination result into the danger degree determination.

In the case where the mobile terminal **10** or a center **40** has, in advance, the information on the locations where traffic accidents frequently occur, the configuration to determine the danger degree based on the location of the mobile terminal **10** may be adopted. In an example, the danger degree determining part **11***c* compares the location information obtained by a location information acquisition part **17** and the information on the locations where traffic accidents frequently occur. When the mobile terminal **10** is located in the periphery of one of the locations where traffic accidents frequently occur, the danger degree determining part **11***c* determines that the danger degree is high, and reflects the determination result into the danger degree determination.

While the vehicle **30** is honking, it is highly possible that a user is in great danger. Thus, when the mobile terminal **10** receives both of the ultrasonic waves output by an ultrasonic wave output part **32** of the vehicle **30** and the ultrasonic waves in human inaudible range that have been superimposed on a honk, the danger degree determining part **11***c* may determine that the danger degree is high, and may reflect the determination result into the danger degree determination.

In the description above, the danger degree is determined in consideration of the relative velocity or the distance to a vehicle or an obstacle, or in consideration of the use status on the mobile terminal **10** (running application, earphone output, etc.). Other than the processing, the danger degree may be determined in consideration of the duration of the while-watching walking state. In an example, when it is determined that a user is in the while-watching walking state, the danger degree determining part **11***c* may increase the danger degree as the duration becomes longer.

The danger degree may be also determined in consideration of the use frequency of the road on which a user is walking. In an example, the roads on which a user has ever walked are stored in memory, and the danger degree may be determined in accordance with the use frequency. Concretely, since the user naturally knows, to some extent, the danger of the road that the user frequently goes through, it is determined that the danger degree is low. On the other hand, since the user naturally does not know much the danger of the road that the user rarely goes through, it is determined that the danger degree is high. In this case, the danger degree determining part **11***c* determines the danger degree by comparing the road on which the user is walking and the past use frequency.

The danger degree determining part **11***c* may determine a comprehensive danger degree only based on each status described above, or based on the combination of various danger degrees. The danger degree determining part **11***c* may determine the comprehensive danger degree in accordance with arbitrary combination of the various danger degrees determined based on various statuses, or in accordance with individually weighted various danger degrees.

<3-4. Others>

In each of the embodiments described above, when the walking state determining processing starts, the first photographing part **14**, the second photographing part **15** and the sound collector **19** of the mobile terminal **10** are activated, and capture various images and collects sound. If a user unconsciously covers any of a first photographing part **14**, a second photographing part **15** and a sound collector **19** with his or her hand, it may be impossible to normally execute the walking state determining processing. Therefore, a mobile terminal **10** monitors whether the user covers the first photographing part **14**, the second photographing part **15** and the sound collector **19** with his or her hand when the walking state determining processing starts. If the user covers any of them, the mobile terminal **10** may notify the user of the fact so as to make the user change how to hold the mobile terminal **10**.

In each of the embodiments described above, various functions are executed by software, especially by CPU processing based on programs. However, some of these functions may be executed by electrical hardware circuits. Contrarily, some of the functions executed through hardware circuits in the above descriptions may be executed through software.

As above, the invention can surely determine that a user is watching a mobile terminal. Moreover, the invention can surely determine that a user is walking because the invention can prevent making misdetermination, even while the user is actually moving on a train or others, not walking. The invention can also surely determine that a user is walking while watching a mobile terminal.

Moreover, the invention can surely determine that a user is in danger, and can also determine user's danger degree if the user is in danger. Then, the invention can notify the user of the applicable details in accordance with the determined danger degree.

While the invention has been shown and described in detail, the foregoing description is in all aspects illustrative and not restrictive. It is therefore understood that numerous other modifications and variations can be devised without departing from the scope of the invention.

What is claimed is:

1. A mobile terminal comprising:
- a display screen;
- a first camera that is installed on a side of the mobile terminal having the display screen;
- a velocity sensor that derives moving velocity of the mobile terminal; and
- a controller configured to
  - determine a starting state of the display screen,
  - determine a direction of a face of a user based on a shot image obtained from the first camera, and
  - determine whether the user is walking while watching the mobile terminal based on the moving velocity, the starting state and the direction of the face of the user.

2. The mobile terminal of claim **1**, wherein
- the controller determines a direction of a visual line of the user based on the shot image obtained from the first camera, and
- the controller determines whether the user is walking while watching the mobile terminal based on the moving velocity, the starting state, the direction of the face of the user and the direction of the visual line of the user.

3. The mobile terminal of claim **2**, further comprising
- a second camera that is installed on an opposite side of the mobile terminal from the side having the display screen, wherein
- the controller determines whether the user is walking while watching the mobile terminal based on the moving velocity, the starting state, the direction of the face of the user, the direction of the visual line of the user, and a change in a shot image obtained from the second camera.

4. The mobile terminal of claim **1**, further comprising
- a second camera that is installed on an opposite side of the mobile terminal from the side having the display screen, wherein
- the controller determines whether the user is walking while watching the mobile terminal based on the moving

velocity, the starting state, the direction of the face of the user, and a change in a shot image obtained from the second camera.

5. The mobile terminal of claim **1**, wherein

the controller determines that the user is walking while watching the mobile terminal when the direction of the face of the user is toward the display screen.

6. The mobile terminal of claim **5**, further comprising

a timer that measures a time during which the direction of the face of the user is toward the display screen, wherein

the controller determines that the user is walking while watching the mobile terminal when the time during which the direction of the face of the user is toward the display screen exceeds a prescribed period of time.

7. The mobile terminal of claim **2**, wherein

the controller determines that the user is walking while watching the mobile terminal when the direction of the visual line of the user is toward the display screen.

8. The mobile terminal of claim **7**, further comprising

a timer that measures a time during which the direction of the visual line of the user is toward the display screen, wherein

the controller determines that the user is walking while watching the mobile terminal when the time during which the direction of the visual line of the user is toward the display screen exceeds a prescribed period of time.

9. The mobile terminal of claim **1**, further comprising:

a sound collector that collects external sound, wherein

the controller determines whether the user is in danger based on a frequency or sound volume of the collected external sound when the user is walking while watching the mobile terminal.

10. The mobile terminal of claim **9**, wherein

the collected external sound is sound output by an external vehicle, and the controller determines whether the user is in danger based on a change in the frequency or in the sound volume of the collected external sound.

11. The mobile terminal of claim **10**, wherein

the controller determines that the user is in danger when the frequency of the collected external sound changes toward a high frequency side, or when the sound volume of the collected external sound increases.

12. The mobile terminal of claim **9**, wherein

the controller determines a danger degree in accordance with an external status of the mobile terminal or a use status on the mobile terminal when the user is in danger.

13. The mobile terminal of claim **12**, wherein

the controller determines the danger degree based on relative velocity of the mobile terminal to an external vehicle or a distance from the mobile terminal to the external vehicle.

14. The mobile terminal of claim **12**, wherein

the controller determines the danger degree based on a type of an application that runs on the mobile terminal or based on whether there is sound output from a sound output part that is installed in the mobile terminal.

15. The mobile terminal of claim **9**, further comprising

a notifying part that, when the user is in danger, performs notification of the danger.

16. The mobile terminal of claim **15**, wherein

the notifying part notifies the user that the user is in danger by one or a plurality of: (i) indication of a letter, (ii) indication of a mark, (iii) outputting of sound and (iv) vibration.

17. A danger notifying system that notifies a driver of a vehicle that a user of a mobile terminal is in danger, the system comprising the mobile terminal and the vehicle, wherein

the mobile terminal includes is the mobile terminal of claim **1**:

wherein the controller of the mobile terminal further determines whether the user is in danger when the user is walking while watching the mobile terminal; the mobile terminal further comprising:

a location information receiver that obtains location information of the mobile terminal; and

a transmitter that transmits the location information of the mobile terminal to the vehicle when the user is in danger, and

the vehicle includes:

a display that displays the location information obtained from the mobile terminal.

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